

PATENT

Docket No.: 19226/835 (R-5285, R-5321, R-5323, and R-5356) #9

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Prasad et al.

Serial No. : 09/265,625

Filed : March 10, 1999

For : TWO-PHOTON UPCONVERTING DYES
AND APPLICATIONS



Examiner:
Kelly O'Hara

Art Unit:
3738

DECLARATION OF GEORGE IAN ALLAN STEGEMAN UNDER 37 C.F.R. § 1.132

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

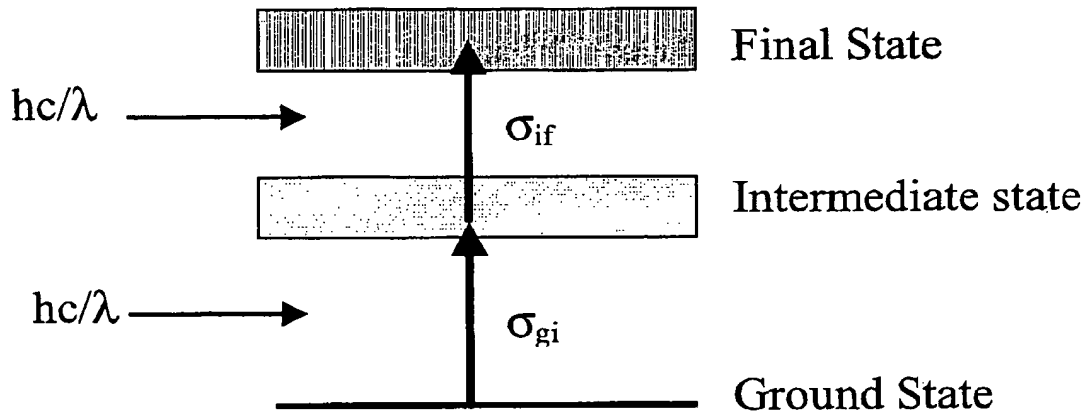
I, GEORGE IAN ALLAN STEGEMAN, pursuant to 37 C.F.R. §1.132,
declare:

1. I received a BASc degree in Engineering Science in 1965, an MSc degree in Physics in 1966, and a Ph.D. degree in Physics in 1969, all from the University of Toronto.
2. I am a Professor at the University of Central Florida at the School of Optics/CREOL®.
3. As demonstrated by my attached resume (attached hereto at Exhibit 1), I have an extensive list of publications, awards, and professional functions in the areas of optics and physics. In view of my knowledge in these areas, I have been retained by applicants as an expert for a fee of \$200 per hour.
4. I have reviewed U.S. Patent Application Serial No. 09/265,625 ("625 application") and believe that it fully discloses the use of simultaneous two photon excitation. The rationale for my conclusion is set forth below.
5. The simultaneous two-photon excitation (commonly known as Two Photon Absorption, or 2PA) phenomena and the step-wise two-photon excitation (commonly known as ESA, Excite State Absorption, or as RSA, Reversible Saturated Absorption) phenomena are shown in the following figures:

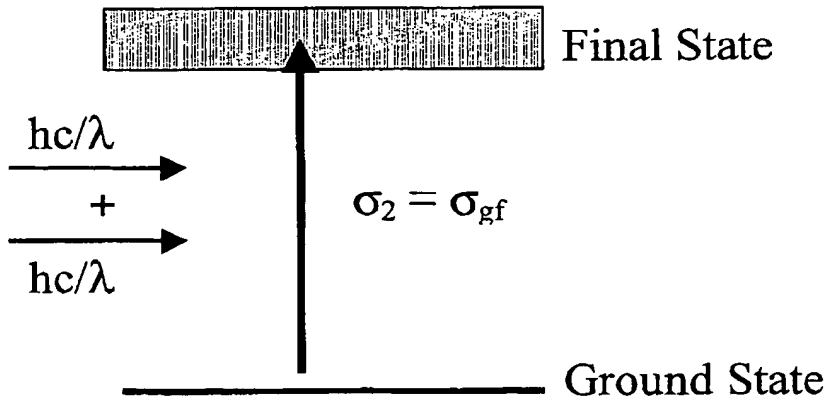
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Step-Wise Two Photon



Direct (Simultaneous) Two Photon



As shown in these figures, the use of simultaneous two-photon absorption involves the simultaneous absorption of two photons (photon energy hc/λ) of a given wavelength λ which leads to the excitation of a two-photon active absorption state at the wavelength $\lambda/2$, i.e. energy $2hc/\lambda$ above the ground state. Thus, the wavelength of the exciting radiation is

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specified for a given material and, for optimum results, the material should be as transparent as possible at the exciting wavelength. On the other hand, as shown in the above figures, in stepwise or sequential two-photon absorption, two sequential absorption events occur, sequentially in time, each involving one photon (photon energy hc/λ). The absorption of the first photon requires significant single photon absorption activity into an intermediate state. This state is evidenced by a lack of transparency at that wavelength. A second, single photon absorption from that first intermediate state into the final state occurs near or at the peak of the second one photon absorption (final) state. The desirability of good transparency at the exciting wavelength range (i.e. 700 – 1300 nm) for photodynamic therapy is discussed on page 8, line 10 to page 9, line 5 of the present application. Since, as noted above, transparency is important for simultaneous two-photon absorption, and absorption is important for step-wise two-photon absorption, one would recognize that the present application intends to use simultaneous two-photon absorption in carrying out photodynamic therapy.

6. The sentence bridging pages 1 and 2 of the '625 application states:

To date, two major technical approaches have been used to achieve frequency upconversion lasing: one is based on direct two-photon (or multi-photon) excitation of a gain medium (two-photon pumped); the other is based on sequential stepwise multi-photon excitation (stepwise multi-photon pumped).

With the latter of these 2 technical approaches clearly referring to sequential multi-photon excitation as discussed above, it is apparent to me that the former alternative is describing simultaneous multi-photon excitation. } good

7. In describing the two-photon absorption or excitation phenomena utilized by applicants, the '625 application sets forth, at page 51, line 6, the following formula:

$$I(L)=I_0/(1 + I_0LB)$$

The '625 application proceeds to describe this equation as follows on page 51, lines 7-10:

$I(L)$ is the transmitted incident intensity; L is the thickness of the matrix material; I_0 is the incident infrared intensity; and β is the

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TPA coefficient of the sample medium and is a linear function of the concentration of the styryl compound in the matrix.

See also page 97, line 30 to page 98, line 11 of the '625 application. This formula is well known by scientists in this area to refer to simultaneous two-photon excitation with β being defined in the field of nonlinear optics as the simultaneous two-photon absorption coefficient. For step-wise two-photon absorption, the relationship is not given in term of the intensity or irradiance, but in terms of an integral over the pulse energy, i.e. the energy or fluence F. On page 98, line 3, β is defined directly in terms of the molecular two-photon absorption coefficient σ_2 as follows:

$$\beta = \sigma_2 N_0 = \sigma_2 N_0 d_0 \times 10^{-3}$$

N_0 is the molecular density of the dopant, σ_2 is the molecular TPA coefficient of the same dopant, and d_0 is the concentration of dopant. This is the formula for simultaneous two-photon absorption but not for the step-wise process which contains the product of the two single photon cross-section coefficients σ_{gi} and σ_{if} , as indicated in the above figures --one for the transition from the molecular ground state to the first excited state (i.e. the intermediate state) and one for the transition from the first excited state to the second excited state (i.e. the final state). Furthermore, the formula for step-wise two-photon excitation would also require values for the pulse duration of the laser and the relaxation time of the first (intermediate) excited state. Thus, the above formulae in the present application would indicate to one of ordinary skill in the art that a simultaneous two-photon excitation process is being used. This is supported by discussions of simultaneous two photon absorption in Eric W. Van Stryland and Lloyd L. Chase, Section 8.2.1, pages 299-328, titled Two Photon Absorption: Inorganic Materials, of the CRC Handbook of Laser Science and Technology, Supplement 2: Optical Materials, Marvin J. Weber Editor; Anthony F. Garito and Mark G. Kuzyk, Section 8.2.2, pages 329-333, titled Two Photon Absorption: Organic Materials, of the CRC Handbook of Laser Science and Technology, Supplement 2: Optical Materials, Marvin J. Weber Editor. This is also supported by

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discussions of step-wise two photon absorption, more commonly known as ESA (Excited State Absorption), and the differences between it and direct two photon absorption (usually just referred to as "Two Photon Absorption") in E.W. Van Stryland, D.J. Hagan and A.A. Said in "Application of Nonlinear Optics to Passive Optical Limiting", chapter 14 in Nonlinear Optics of Organic Molecules and Polymers, edited by H.S. Nalwa and S. Miyata, pp 841-860 (CRC Press)

8. Further, my analysis of the experimental data set forth in the '625 application demonstrates that the applicants were utilizing simultaneous two-photon excitation. Figure 7 of the '625 application shows the absorbance spectrogram of a "dye1" doped film used in accordance with the '625 application, where this dye has no absorbance when subjected to incident photons with a wavelength greater than 600 nm, most specifically the wavelength of the Nd:YAG laser at 1060 nm. This dye and its method of preparation is described on page 95 of the '625 application in Example 6. Figure 9, as described in Example 11 (pages 97-98 of the '625 application), shows that when dye1 (i.e. trans-4[p-(N-ethyl-N-hydroxyethyl amino)styryl]-N-methylpyridinium tetraphenylborate) is subjected to a Nd:YAG laser of wavelength of 1060 nm (i.e. 1.06 μ m), an intensity-dependent absorption, quadratic in the input intensity, is obtained due to two photon absorption. Since Figure 7 shows that dye1 has no absorbance at 1060 nm, I conclude that the nonlinear transmission shown in Figure 9 results from simultaneous two-photon absorption. The absorbance required by the observed transmission shown in Figure 9 cannot be due to single photon excitation or sequential two-photon excitation, because dye1 is not capable of being excited to any level (either a full absorbance level or an intermediate one) at an incident wavelength of over 700 nm.

9. My further analysis of the experimental data set forth in the '625 application demonstrates that the applicants were utilizing simultaneous two-photon excitation. Figure 10 of the '625 application shows the absorbance spectrogram of a "dye 1" doped film used in accordance with the '625 application, where this dye has no absorbance when subjected to incident photons with a wavelength greater than 600 nm, most specifically the wavelength of the Nd:YAG laser at 1060nm. This dye and methods for its preparation are described on page 95 of the '625 application in Example 6, and on pages 98-99 in Examples 12-14 of the '625 application. Figure 11B, as described in Example 15 (pages 99-102 of the '625 application), shows that when dye1 (i.e. trans-4[p-(N-ethyl-N-hydroxyethyl

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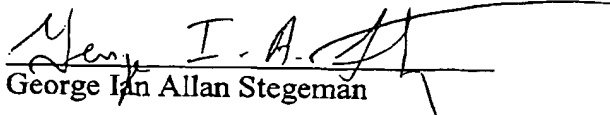
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amino)styryl]-N-methylpyridinium tetraphenylborate) is subjected to a Nd:YAG laser of wavelength of 1060 nm (i.e. 1.06 μm), a photon is emitted at 600 nm due to two photon induced fluorescence. Since Figure 10 shows that dye1 has no absorbance at 1060 nm, I conclude that the emission shown in Figure 11B results from simultaneous two-photon excitation. The absorbance required by the fluorescence shown in Figure 11B cannot be due to single photon excitation or sequential two-photon excitation, because dye1 is not capable of being excited to any level (either a full absorbance level or an intermediate one) at an incident wavelength of over 700 nm.

10. Based on all the foregoing, I conclude that the '625 application clearly discloses, to one of ordinary skill in the art, the use of simultaneous two-photon excitation.

11. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: December 18, 2000


George Ian Allan Stegeman

GEORGE IAN ALLAN STEGEMAN

Professor of Optics, Physics and Electrical Engineering
Cobb Family Distinguished Scholar Chair

Date and place of birth: 8/4/42 Edinburgh, Scotland

Citizenship: Canadian Social Security No.: 526-87-0673

Educational background:

University of Toronto	
PhD, Physics	1969
MSc, Physics	1966
BASc, Eng. Science	1965

Employment history:

CREOL, Un. Central Florida	Professor	1990-
Universite Pierre et Marie Curie		1986
(Professeur Invitee)		
University of Arizona		
Optical Sciences Center	Professor	1980-1990
University of Toronto	Professor of Physics	1979-1980
	Associate Professor	1975-1979
	Assistant Professor	1970-1975
	Postdoctoral Fellow	1969-1970

PHONE NO: 1-407-823-6915 FAX NO: 1-407-823-6955

Fields of major current interest:

Nonlinear Properties of Organic and Semiconductor Films
Linear and Nonlinear Integrated and Fiber optics
All-Optical Waveguide Phenomena
Waveguide Second Harmonic Generation
Soliton Generation, Propagation and Interactions

Professional activities:

Society Memberships
American Physical Society
Optical Society of America
Institute of Electrical and Electronics Engineers

Materials Research Society

Awards:

Hertzberg Medal for Achievement in Physics (CAP), 1980

Fellow of the Optical Society of America, 1982

Fellow of the American Physical Society, 1999

UCF Researcher of the Year, 1998

Conference Committees

Canadian Association of Physicists Annual Meeting Program Committee, 1977

Optical Society of America (OSA), Annual Meeting Program Committee, 1977, 1982, 1986

Chairman, Annual OSA Meeting, 1977 and 1982

Program Committee, CLEO, 1983

Organizer of ARO Surface Plasmon Workshop, 1983

Organizer of NASA Workshop on Applications of Surface Plasmons to Solar Energy

Co-director of Ettore Majorana Summer School on "Surface Electromagnetic Waves", 1985

Program Committee, SPIE International Conference on Integrated Optical Engineering, 1985 and 1986

Program Committee, SPIE Symposium on Molecular and Polymeric Materials: Fundamentals and Applications, 1986

Program Committee, Trends in Quantum Electronics '88, Bucharest, Romania

Program Committee, IGWO'88, '89

Program Committee, IQEC '88,

Conference Cochairman, Topical Meeting on Nonlinear Guided Wave Phenomena, 1989

Steering Committee, Topical Meeting on Nonlinear Guided Wave Phenomena

Local Committee of USA-USSR International Symposium on Laser Interaction with Matter, 1990, Irvine California

Organisation Committee: International School on "Nonlinear Guided Wave Phenomena", Cargese July 1-15, 1991

International Committee: ISSWAS'89

Steering Committee: Topical Meeting on Integrated Photonics Research, 1988-92

Chair: Program Subcommittee for Nonlinear Guided Wave Phenomena, Topical Meeting on Integrated Photonics Research, 1990

Advisory Committee: SPIE Symposium on Optical and Optoelectronic Applied Science and Engineering

Program Co-Chair: 1991 Integrated Photonics Research Meeting

Technical Program Committee: India-US Workshop on Emerging Optoelectronic Technologies, India, Dec. 1991

Technical Program Committee: QELS'91 and 92

Organizing Committee: OLC'91

Program Co-chair: QELS'93

Organizer: Workshop on Theory of Nonlinear Guided Waves, Cocoa Beach, April 1992

Program Committee: ILS'92

Co-Chair: Nonlinear Optical Measurements in Advanced Materials,

SPIE E-O LASE'93

Technical Program Committee: ACS/OSA Topical Meeting: Organic Thin Films for Photonic

Applications, 1993, 1994

Program Co-Chair: ACS/OSA Topical Meeting: Organic Thin Films for Photonic Applications, 1995, 1996

Meeting Co-Chair: ACS/OSA Topical Meeting: Organic Thin Films for Photonic Applications, 1997, 1998

Technical Program Committee: Nonlinear Guided Wave Phenomena '93

Chair: QELS'95

Program Committee: ICONO'2 (1995)

Technical Program Committee: QELS'96

Meeting Co-Chair: Nonlinear Guided Wave Phenomena, 1996

Local Chair and Program Committee: ICONO'3, 1996

Program Committee: LEOS'96

Sub-Committee Technical Program Chair: QELS'97

Organization Committee: International School on "Beam Control with Nonlinear Optics", Cargese, France, August 4- 17, 1997

Organization Committee: International School on " $\chi^{(2)}$ Phenomena", Sozopol, Bulgaria, September 22 - October 3, 1997

Organization Committee: International School on "Solitons and Their Applications", Le Houches, France, September, 1998

Honorary Chair: 1998 International Photonics Conference, Taipei, Taiwan, December 1998

Program Committee: Topical Meeting on "nonlinear Optics, Phenomena and Applications", Maui, Hawai, August 2000

Co-Organizer: International NATO School on "Soliton Driven Photonics", Swinoujscie , Poland, September 25 - October 4, 2000

Local Organizer: Soliton Workshop, Orlando Florida, March 2001

Organizing Committee, XVII International Conference on Coherent and Nonlinear Optics (ICONO 2001), Minsk, Belaruss, June 26 – July 2 2001

Committee Chair, IQEC 2002, Moscow Russia, July 2002

Society Committee Service

CAP Regional Councillor, 1974-6

CAP President Optics Division, 1976-7

Optics in Canada Review Committee, 1981

OSA Meggers Award Committee 1982

OSA C.H. Townes Award Committee 1986-8

OSA Education Committee 1985-7

OSA Chairman C.H. Townes Award Committee 1987

OSA Board of Directors 1986-9

OSA Executive Committee of the Board of Directors, 1988

OSA Publications Committee, 1989-92

IEEE/LEOS Technical Committee on Integrated Optoelectronics

OSA Adolph Lomb Medal Committee, 1994-5

OSA/IEEE Joint Council on Quantum Electronics, 1997-9

Editorial Boards

Editorial Board, Wave Electronics 1979-83
Editorial Board, Applied Physics Letters and Journal of Applied Physics, 1987-9
Editorial Board, Optics Communications, 1986-2000
Editorial Board, Nonlinear Optics and Electrooptics part of Journal of Molecular Crystals and Liquid Crystals
Advisor, Journal of Optical and Quantum Electronics
Editorial Board, book series titled "Electromagnetic Waves - Recent Developments and Applications"
Associate Editor, Optics Letters, 1989-
Editorial Board, book series titled "Optics and Photonics"
Editorial Board, Journal of Optical Materials, 1991-2
Editorial Board, Journal of Nonlinear Optics, 1991-
Associate Editor, JOSA B, 1992-6
North American Editor, J. Optical and Quantum Electronics, 1997-2000
Editor-in-Chief, J. Opt. Soc. Am. B, 2001-

Other

NSF Engineering Center Panel, 1985
AIP Search Committee for Editor for Applied Physics Letters, 1986
NSF Engineering Group Research Panel, 1987
NSF Lightwave Technology Research Initiation Award Panel, 1988
NSF Advisory Committee for Emerging Engineering Technologies, June 1988-May 1989
NSF Advisory Committee for Lightwave Technology, 1988
Canadian NSERC Grant Committee, 1989-92
NSF Young Investigator Panel Member, 1996

Publications:

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"New Physics and Applications of Kerr Spatial Solitons in AlGaAs Waveguides", Annual OSA Meeting, Santa Clara, September 27-30, 1999

"Photodegradation of Azobenzene Electro-optic Polymers", ACS/OSA Topical Meeting on Photonics Applications of Organic Thin Films, Santa Clara, September 24-26, 1999

"Experimental Examples of Soliton Based Instabilities", Soliton Workshop in 1999 British Conference on Quantum Electronics, Manchester England, September 6 1999

"New Physics and Applications of Kerr Spatial Solitons in AlGaAs Waveguides", Nonlinear Guided Wave Phenomena, Dijon France, August 30 - September 2, 1999

"Resonantly Enhanced Multiphoton Absorption in Conjugated Polymers", NATO workshop on Multiphoton Excitations in Organics and Their Applications, Menton France, 25-30 August, 1999

"Photodegradation of Azobenzene Electro-optic Polymers", (given by Adriana Galvan-Gonzalez) Seminars, Institute of Optics, Orsay; University of Cachan, Bagneux, France, July 1999

"Bright Spatial Solitons: Particles or Waves?", Seminars, Institute of Optics, Orsay; CEN, Saclay, France, July 1999

"Resonantly Enhanced Multiphoton Absorption in Conjugated Polymers", Conference on Nonlinear Optical Materials", Cetraro Italy, June 1999

"Bright Spatial Solitons: Particles or Waves?", Colloquium, ETH, Zurich Switzerland, June 1999

"State-Of-The-Art of Spatial Solitons in $\chi^{(2)}$ Materials", USA-Germany Workshop on Quadratic Solitons, University of Paderborn, Paderborn Germany, April 1999

"Solitons in Quadratically Nonlinear Media", colloquium, Dept. Physics, Frederick Schiller University, Jena Germany, April 1999

"Properties of Two-Dimensional Quadratic Spatial Solitons in Type I Potassium Niobate", (given by R. Malendevich), SPIE Aerosense, Orlando, April 1999

"Polymer Conductivity Matching: A Promising Route Toward Highly Efficient SHG in Polymer Waveguides", (given by V. Ricci), SPIE Aerosense, Orlando, April 1999

"Importance of Material and Operational Parameters Limiting the Photostability of Electro-optics Chromophore Doped Polymers", MRS'99 Spring Meeting, San Francisco, April 1999

"Bright Spatial Solitons: Particles or Waves?", Dept. Physics Clemson, March 1999

"Cascading: Physics and Applications", (plenary talk) 1998 International Photonics Conference, Taipei, December 1998

"Family of Type II Quadratic Solitons and Their Applications", LEOS'98, Orlando, December 1998

"Multiphoton Absorption and Higher Order Nonlinearities in Polydiacetylenes: PTS", 8'th Iketani Conference, Hokkaido Japan, October 1998

"A Comparison of Second Harmonic Generation Utilizing Quadratic Spatial Solitons Versus Conventional Methods", (upgraded paper, given by M. Ohkawa), Annual OSA Meeting, Baltimore, October 1998

"Quadratic Solitons", Workshop on Solitons, Les Houches, September 1998

"Experiments on Bright Quadratic Solitons", Polish NLO conference, Miedzyzdroje Poland, September 1998

"Casacading: An Old Idea with New Twists", OPTEC conference on Optical Science and Laser Technology, Bozeman Montana, August 1998

"Experiments on Bright Quadratic Solitons", XVI International Conference on Coherent and Nonlinear Optics, Moscow, July 1998

"Bright Spatial Solitons", short course at XVI International Conference on Coherent and Nonlinear Optics, Moscow, July 1998

"Overview of Polymers for Communications", European Materials Research Society, Strasbourg, June 1998

"Experiments on Bright Quadratic Solitons", European Commission COST P2 Workshop, Limerick Ireland, June 1998

"Bright Quadratic Solitons", ARO Workshop on Solitonic Gateless Computing, Rayleigh-Durham, May 1998

"Extended Family of Type II Quadratic Solitons Excited by Fundamental Waves of Unequal Energy", (given by R. Fuerst), IQEC'98, San Francisco, May 1998

"Thin Film Devices for All-Optical Switching and Processing Via Quadratic Nonlinearities", (given by G. Assanto) CRL International Symposium on Advanced Technologies in Optical communication and Sensing", Tokyo, December 1997

"Advantages of Modal Dispersion Phase Matching and Material Requirements for Devices Using Efficient SHG at Telecommunications Wavelengths", (given by M. Canva), MRS Fall'97 Meeting, Boston, December 1997

"Beam Instabilities in Quadratic Media", IEEE LEOS Annual Meeting, San Francisco, November, 1997

"Multiphoton Absorption in Conjugated Polymers: PTS", Air Force Workshop on Multiphoton Absorption and its Applications, Dayton, October 1997

"Second Harmonic Generation in Multilayer Poled Polymer Waveguides", Annual OSA Meeting, October 1997

"Progress in Quadratic Solitons", Annual OSA Meeting, October 1997

"Second Harmonic Generation with Polymeric Waveguides", (given by M. Canva), International Conference on Polymer Optical Fibers, Hawaii, September 1997

"Experiments with Quadratic Solitons", 3 lectures, NATO Summer School on $\chi^{(2)}$, Sozopol (Bulgaria), September 1997

"Second and Third Order Nonlinear Optics in Semiconductors and Polymers: Second Harmonic and Soliton Generation", Symposium of the Center of Excellence in "Physics and Chemistry of Optical Films", Jena, August 1997

"Fundamentals of Nonlinear Optics", (3 hours of lectures), NATO Advanced Institute on Beam Control with Nonlinear Optics, Cargese, August 1997

"Cascaded Nonlinear Optics", Gordon Conference on Nonlinear Optics, Tilton Academy, July, 1997

"Poling and Characterization of Photonic Waveguide Devices for Efficient Second-Harmonic Generation", (given by Matthias Jaeger), SPIE Symposium on xxx, July 1997

"Progress in co-directional second harmonic generation in poled polymers", KIST, Seoul Korea, July 1997

"Experimental Demonstrations of Spatial Solitons", KAIST, xxx Korea, July 1997

"Cascaded Nonlinear Optics", Pusan National University, Pusan Korea, July 1997

"Progress in co-directional second harmonic generation in poled polymers", Special Symposium on Organic Optical Materials at SSLMA'97, Tianjun China, July 1997

"Counter-propagating mixing second harmonic generation in poled polymer waveguides", (given by A. Otomo), Special Symposium on Organic Optical Materials at SSLMA'97, Tianjun China, July 1997

"Experimental Realizations of Spatial Solitons", Summer School on Solitons : Concepts And Recent Developments, Université de Bourgogne, Dijon, France; ESERG-LEMO University of Grenoble, Grenoble, France; Laboratoire d'Optique des Surfaces et des Couches Minces, University of Marseilles, Marseilles, France, June 1997

"Three-wave simultons:quasi particles in quadratic media", (given by G. Assanto), Italian Summer School, Cetaro Italy, June 1997

"Spatial Soliton Robustness against spatially anisotropic phase perturbations", (upgrade given by J.U. Kang), QELS'97, Baltimore, May 1997

"Poled Polymer Second Harmonic Generation", Trinity College, Dublin, Ireland, April 1997; and Université Pierre et Marie Curie, Paris, France, May, 1997

Spatial Solitons in Bulk PTS", Trinity College, Dublin, Ireland, April 1997

"Bright Spatial Solitons in AlGaAs Waveguides", (given by J. Aitchison), 10'th Optical Engineering Meeting, Jerusalem, Israel, March 1997

"Nonlinear Optical Materials and the Experimental Realization of Spatial Solitons", Photonics Workshop, Guadalajara Mexico, January 1997

"Progress Towards WDM Demultiplexing with Sum and Difference Frequency Generation in Poled Polymers", Fourth International Conference on Frontiers in Polymers and Advanced Materials, Cairo Egypt, January 1997

"Recent advances in the design and use of the real and imaginary third-order optical nonlinearities of organic dyes", (given by M. Barzoukas) Third International Conference on Organic Nonlinear Optics, Marco Island, FL, December, 1996.

"Preparation and in-situ electro-optical investigation of poling structures for phasematched second-harmonic generation in waveguides", (given by S. Yilmaz), Third International Conference on Organic Nonlinear Optics, Marco Island, FL, December, 1996.

"Second Harmonic Generation, A New Look at an Old Effect", seminar, University of Indiana in Bloomington, December 4, 1996

"Cascading Nonlinear Optics", seminar, Bell Labs, November 1996

"Applications of Cascading Nonlinear Optics", Annual LEOS'96 Meeting, Boston, November 1996

"Spatial Solitary Waves using Second Order Nonlinearities", (given by B. Lawrence), Annual LEOS'96 Meeting, Boston, November 1996

"Cascading Spatial Soliton Phenomena", (given by Torruellas) Annual ILS/OSA Meeting, Rochester NY, October 20-25 1996

"Nonlinear Optical Materials and the Experimental Realization of Spatial Solitons", Workshop on Nonlinear Optical Phenomena and Applications, Kaziemierz Poland, September 1996

"Cascaded Second-Order Nonlinearities", (given by R. Schiek), URSI XXVth General Assembly, Lille, France, August 1996

"Observation of Manakov spatial solitons in AlGaAs planar waveguides", upgraded invited, IQEC'96, Sydney, Australia, July 1996

"Cascaded Optical Nonlinearities in Organic Structures", (given by Torruellas), IQEC'96, Sydney, Australia, July 1996

"Experimental Progress in Cascading Nonlinear Optics", Nonlinear Optics: Phenomena and Applications, Maui, July 1996

"Trapping of Light Beams and Formation of Spatial Solitary Waves in Quadratic Nonlinear Media", (given by Lluís Torner), QELS'96, Anaheim, June 1996

"Cascading $\chi^{(2)}$ Processes", Workshop on $\chi^{(2)}$ Second Order Nonlinear Optics: From Fundamentals to Applications, Les Houches France, April 1996

"Sum Frequency Generation in Composite Polymers", China-USA Workshop on Composite Materials, Nanjing China, April 1996

"All-optical Switching based on Spatial Solitons", (given by J. Kang), SPIE Conference "Aerosense", Symposium on Digital Signal Processing Technology, Orlando, April 1996

"All-Optical Materials and Their Applications to Communications", CRL International Symposium on Advanced Technologies in Optical communication and Sensing", Tokyo, March 1996

"Use of AlGaAs in All-Optical Communications", (given by A. Villeneuve), Canada-US Workshop on Frontiers of Quantum Electronics, Toronto, Canada, February 1996

"AlGaAs Below Half Bandgap: A Laboratory for Spatial Soliton Physics", Materials for Nonlinear Optics, Val Thorens, January 1996

"Second Harmonic Generation with Poled Polymers", MRS Meeting, Boston, November 1995

"Nonlinear Optics in AlGaAs", (given by A. Villeneuve), IEEE LEOS Annual Meeting, San Francisco, October 1995

"Observation of Two Dimensional Spatial Solitary Waves in a $\chi^{(2)}$ Medium", (given by W. Torruellas), IEEE LEOS Annual Meeting, San Francisco, October 1995

"Multiplexing and Demultiplexing in AlGaAs Directional Couplers", (given by A. Villeneuve), IEEE LEOS Annual Meeting, San Francisco, October 1995

"Nonlinear Semiconductor Waveguide Switching Devices", Active Waveguide Workshop, Southampton, September 1995

"Cascaded $\chi^{(2)}$ Nonlinearities", QE-12, Southampton, September 1995

"AlGaAs Waveguides Below Half the Bandgap: A Laboratory for Nonlinear Optical Phenomena", Third International Aalborg School on Nonlinear Optics, Aalborg Denmark, August 1995

"Lightwave manipulation in guided wave geometries: $\chi^{(2)}$ ", ICONO'2, Japan, July 1995

"Overview of Third Order Nonlinear Materials for Communications Devices", Workshop on *Recent Progress of Optical Materials and Devices*, Tokyo Japan, July 1995

"Cascading: A Promising Approach to Nonlinear Optics Revisited", Frontier Materials Forum on *Recent Progress in Organic Nonlinear Optical Materials*, Japan, July 1995

"Two-Photon Processes and Cascading Effects in Organics", NATO Advanced Research Workshop on *Photoactive Organic Materials*, Avignon France, June 1995

"Cascading: A New Approach to Nonlinear Guided Wave Phenomena", Italian Summer School, Cetaro Italy, May 1995

"2-D Spatial Solitary Waves in a Quadratic Medium", QELS'95 (given by W. Torruellas), Baltimore, May 1995

"Cascaded Nonlinearity in LiNbO₃ Waveguides", CLEO'95 (given by R. Schiek), Baltimore, May 1995

"Photonics Applications of Spatial Soliton Switches", SPIE Aerosense 95, April 1995

"Cascading of 2nd Order Nonlinear Processes", European Conference on Integrated Optics, Delft Holland, April 1995

"Nonlinear Optical Materials for Information Processing", Royal Society Meeting on "Nonlinear Optics for Information Processing", London, March 1995

"Ultrafast All-Optical Switching in Semiconductor Waveguides", given by C. Ironside, Topical Meeting on Nonlinear Guided Wave Phenomena and Their Applications, Dan Point, California, February 1995

"Second Harmonic Generation by Counter Propagating Guided Waves: A Novel Geometry with Novel Applications", Third International Conference on Frontiers in Polymers and Advanced Materials, Kuola Lampour (Malasia, January 1995

"Cascading: A New Route to All-Optical Nonlinearities and Devices", Symposium on Guided Wave Optoelectronics: Device Characterization, Analysis and Design", Brooklyn, October 1994

"Large Nonlinear Phase Shifts in Waveguides due to Cascading of Second Order Nonlinearities", (given by W. Torruellas), Annual OSA Meeting, Dallas, October 1994

"Cascading: A New Route to All-Optical Nonlinearities and Devices", Joint Meeting of American, Canadian and Mexican Physical Societies, Cancun (Mexico), September, 1994

"Integrated Optics and Waveguide Switching", NATO Summer School on Fabrication, Properties and Applications of Low-Dimensional Semiconductor Structures, Nessebar (Bulgaria), September 1994

"Large Effective Third Order Nonlinearities in DAN Crystal Core Fibers via Cascading", (given by W. Torruellas), ACS/OSA Topical Meeting on Organic Thin Films for Photonics", Washington, August 1994

"Second Harmonic Generation by Counter-Directed Waves in Poled Polymer Waveguides", ACS/OSA Topical Meeting on Organic Thin Films for Photonics", Washington, August 1994

"Nonlinear Optics of Conjugated Polymers: Physics and Applications, Fifth Annual Symposium of the NSF Center for Photoinduced Charge Transfer", Rochester, August 1994

4 lectures on various aspects of nonlinear waveguide phenomena, Frederick Schiller University, Jena Germany, July 1994

"Perspectives on Third Order Nonlinear Materials for Devices", MITI Conference on Nonlinear Photonics Materials, Tohoku University Japan, May 25-26, 1994

"Recent Advances in Non-Resonant Nonlinearities in Organic Materials", Iketani Conference on Optically Nonlinear Organic Materials, Hawaii, May 16-20, 1994

"Nonlinear Refraction and Absorption in Polydiacetylenes", 2nd Conference on Optical Probes of conjugated Polymers", Salt lake City, February 15-19 (1994)

"All-Optical Switching with Second-Order Nonlinearities", (given by E. VanStryland), Snowbird Winter School on the Physics of Quantum Electronics, January 1994

"Nonlinear Spectroscopy in Organic Molecules", International Conference on Organic Nonlinear Optics", Val Thorens France, January 9-13 (1994)

"Spectral dispersion of the complex nonlinear refractive index of PTS", (given by W. Torruellas) SPIE Meeting, Los Angeles, January 1994

"Issues in organics for nonlinear optics", MRS Fall Meeting, Boston, December 1993

"Nonlinear Polymers for All-Optical Processes", Int. Symposium on Polymers for Microelectronics, Tokyo, Nov 15-19, 1993

"Nonlinear Integrated Optics", OSA 93, Toronto, October 1993

"Nonlinear Spectroscopy of Thin Organic Films", OSA Topical Meeting on Nonlinear Organic Films, Toronto, October 1993

"Large Nonlinear Phase Modulation in Quasi-Phase-Matched KTP Waveguides due to Cascaded Second Order Processes", (given by M. Sundheimer), Nonlinear Guided Wave Phenomena Topical Meeting, Cambridge, September 1993

"Optical Nonlinearities Near Half the Band-Gap in Semiconductors and Their Applications", (given by C.C. Yang), Internat. Conf. on Nonlinear Optical Physics and Applications, Nanjing China, September 1993

"AlGaAs Below Half the Band Gap: The Silicon of Nonlinear Optical Materials", School and Topical Meeting on Applications of Nonlinear Optics, Prague, August 16-20, 1993

"AlGaAs Below Half Band Gap: The Silicon of Nonlinear Optical Materials", Gordon Conference on Nonlinear Optics, August 2-6, 1993

"Integrated Optics and All-Optical Waveguide Switching", Erice summer school, July 13-26, 1993

"Nonlinear Spectroscopic Studies of Polydiacetylenes", (given by W. Torruellas), SPIE, San Diego, July 1993

"Nonlinear Integrated Optics", Institute of Optics Summer School on Nonlinear Optics, Rochester, June 1993

"Nonlinear Optical Devices Below Half Band Gap", (given by S. Aitchison), ECIO'93, Neuchatel Switzerland, April 1993

"Nonlinear Spectroscopy Of Conjugated Polymers", MRS Spring Meeting, San Francisco, April 1993

"Current Status of Nonlinear Materials and Their Applications to Waveguide Devices", Integrated Photonics Research, Palm Springs, March 1993

"Material Figures of Merit and Implementations of All-optical Waveguide Switching", SPIE, Los Angeles, January 1993

"Nonlinear Optical Photonic Devices: Relative Status Of Polymeric Materials", Second International Conference on Frontiers of Polymers and Advanced Materials, Jakarta Indonesia, Jan 10-15, 1993

"Linear and Nonlinear Optical Properties of Polymers", American Institute of Chemical Engineering, Miami, November 1992

"Nonlinear Fiber Filter: Demonstration of Phase-Controlled Switching, Optical Logic and Demultiplexing", Workshop on Materials and Devices for Ultrafast All-Optical Switching, Twente Holland, October 1992

"Elastic Properties of MBE-Grown Crystalline Metallic Films and Multilayers", IEEE Ultrasonics Symposium, Tuscon, October 1992

"Large Nonlinear Phase Shifts Via Second Order Processes", Workshop on Materials and Devices for Ultrafast All-Optical Switching, Twente Holland, October 1992

"Device Considerations for Nonlinear Optical Materials", US-France Workshop on the Chemistry of Optical Materials, Maubuisson France, Sept. 29-Oct. 2, 1992

"Ultrafast Switching in AlGaAs Waveguide Devices", given by J.S. Aitchison, OSA'92 Annual Meeting, Albuquerque, September 1992

"Cascading for Large Third Order Nonlinearities", given by E. VanStryland, Nonlinear Optics: Materials, Fundamentals and Applications", Maui Hawaii, Aug. 17-21 (1992)

"Nonlinear Organics: Will they be used for Devices?", Gordon Conference on Transport and Nonlinearities in Organic Materials", New Hampshire, July 26-31, 1992

"Efficient All-Optical Switching in AlGaAs at 1.55 Microns", Fourth Optoelectronics Conference, Chiba Japan, July 15-17, 1992

"Current Topics in Nonlinear Guided Waves", Capri, June 1-5, 1992

"Very Large Third Order Nonlinearities Via Cascading of Second Order Nonlinearities", IQEC'92, Vienna Austria, June 1992

"Nonlinear Optical Interactions in AlGaAs Near One Half Band Gap", QELS'92, Anaheim CA, May 11-15, 1992

"6 Lectures on Nonlinear Photonics", INOE 50'th Anniversary Lectures, Mexico, April 1992

"Characterization of Organic Materials for All-Optical Switching Devices", given by Dieter Neher, Workshop on Organic Optoelectronic Materials, Monterey, March 1992

"Nonlinear Organics: Will they be used for Devices?", American Physical Society Spring Meeting, Indianapolis, March, 1992

"Ultrafast All-Optical Switching", AAPT Winter Meeting, Orlando Florida, January 6, 1992

"Nonlinear Optics of Conjugated Polymers", MRS Meeting, Boston, December 1991

"All-Optical Switching Devices: Fiber Versus Integrated Optics", 16'th Australian Conference on Optical Fibre Technology, Adelaide, December 1991

"Enhanced Elastic Constants of Ag/Pd Superlattice Films", (given by J.R. Dutcher), Office of Naval Research Workshop on the Elastic Properties of Multilayers and Superlattices, Tucson, October 1991

"Overview of Nonlinear Characterization Techniques", Ceramic Society, Washington, October 1991

"Material Requirements for Nonlinear Third Order Phenomena in Waveguides", Toyota Conference on Nonlinear Optics, Nagoya, October 6-9, 1991

"Nonlinear Optics of Polymers", ILS-VII, Monterey, CA, September 1991

"Prospects for Nonlinear Organics in Waveguides", Topical Meeting on Nonlinear Guided Wave Phenomena, Cambridge UK, September 1991

"Nonlinear Optical Probes of Conjugated Polymers", (given by Dieter Neher) Optical Probes of Conjugated Polymers, Salt Lake City, August 1991

"Introduction to Nonlinear Guided Wave Phenomena", NATO Advanced Institute on Nonlinear Guided Wave Phenomena, Cargèse, August 1991

"Nonlinear Integrated Optics", Institute of Optics Summer School on Nonlinear Optics, Rochester, June 1991

"Nonlinear Integrated Optics", SPIE Short Course, Dallas, May 1991

"Superlattice Mechanical Properties of LB Films", MRS Meeting, Anaheim, May 1991

"Material Requirements for All-Optical Devices: Nonlinear Properties of Poly4-BCMU", MRS Meeting, Anaheim, April 1991

"Nonlinear Optical Devices: Status of Polymeric Materials", MRS, Anaheim, April 1991

"Nonlinear Optical Devices: Relative Status of Polymeric Materials", Int. Conf. on Frontiers of Polymer Research, Delhi, January 1991

"Nonlinear Optoelectronic Devices", Second International School on Photonics, Oaxtepec Mexico, January (7-18) 1991

"Optical Nonlinearities in Composite Semiconductor Waveguides", Second International Ceramic Science and Technology Congress, Orlando, November 1990

"Nonlinear Optical Devices: Current Status", OMNO 90, Oxford, September 1990

"Nonlinear Optics in Waveguides", Gordon Conference on Dielectric Phenomena, New Hampshire, July 1990

"Nonlinear Guided Wave Grating Phenomena", Topical Meeting on Nonlinear Optical Devices and Materials, Honolulu, July 1990

"Nonlinear Integrated Optics", Institute of Optics Summer School on Nonlinear Optics, Rochester, June 1990

"Nonlinear Guided Wave Phenomena", France-Israel Conference on Nonlinear Optics, April 1990

"Device Applications of $\chi^{(3)}$ Materials", tutorial for American Chemical Society Annual Meeting, Boston, April 1990

"Two Photon Absorption: Limitation to All-Optical Switching, Workshop on Space-Time Complexity in Nonlinear Optics, Tucson, March 1990

"Nonlinear Guided-Wave Grating Phenomena", (given by J. Ehrlich), Int. Conf. on Optical Science and Engineering, The Hague Netherlands, March 1990

"Progress in Waveguide Structures and Devices", International Chemical Congress of the Pacific Basin Societies, Honolulu, December 1989

"Progress in Semiconductor Doped Glass Waveguides", International Symposium on New Glass, Tokyo, November 1989

"Nonlinear Optics in Semiconductor-Doped Glass Waveguides", ISSWAS'89, Sofia Bulgaria, September 1989

"Saturation of Nonlinearities and Waveguide Device Implications", San Diego, August, 1989

"Nonlinear Optics in Planar Waveguides", SPIE short course, San Diego, August, 1989

"All-Optical Switching in Waveguide Geometries", IOOC'89, Kobe Japan, July 1989

"Nonlinear Optical Waveguides", tutorial at IOOC'89, Kobe Japan, July 1989

"Overview of Nonlinear Integrated Optics", Ettore Majorana Summer School on "Nonlinear Guided Wave Phenomena in Solid State Physics", Erice Italy, July 1989

"Metallic Multilayers and Superlattices", (given by J.R. Dutcher) American Crystallographic Assoc. - Symposium on Interface Science and Technology, Seattle WA, July 1989

"Elastic Properties of Langmuir-Blodgett Films", Central Regional Meeting, American Chemical Society, Cleveland, May 1989

"Nonlinear Guided Wave Devices" and "All-Optical Guided Wave Switching", Second Annual Photonics Symposium of the New York State Science and Technology Foundation, Binghamton NY, May 1989

"Brillouin Spectroscopy of LB Films", (given by Wolfgang Knoll) Fourth International Conference on Langmuir-Blodgett Films, Tsukuba, Japan, April 1989

"All-Optical Switching in Fibers", V National Symposium on Optical Fibers, Warsaw, Poland, February 1989

"Materials Implications of Nonlinear Optical Devices", (given by R.H. Stolen) Fourth International Conference on Ultrastructure Processing of Ceramics, Glasses and Composites, , Tucson, February 1989

"Brillouin Scattering in Langmuir-Blodgett Films", (given by Wolfgang Knoll) SPIE Conference on Photochemistry in Thin Films, January 1989, Los Angeles

"Nonlinear Guided Wave Materials and Devices", Glass Meeting of the American Ceramic Society, Tucson, November 1988

"Modulated Index Structures in Thin Films", OSA Annual 1988, Santa Clara, November 1988

"Progress in Nonlinear Guided Wave Phenomena", Lasers and their Applications, Plovdiv (Bulgaria), October 1988

"Nonlinear Optics in Thin Films", Annual Vacuum Society Meeting, Atlanta, October 1988

"Brillouin Scattering at Surfaces and in Thin Films", Workshop on Scattering of Electromagnetic Radiation, Madrid, September 1988

"Second-Harmonic Generation as a Probe of Thin Film and Monolayer Microstructure" (to be given by V. Mizrahi) Trends in Quantum Electronics '88, Bucharest, August 1988

"Photo-Induced Nonlinearities in Optical Glass Fibers" (given by U. Osterberg) Nonlinear Optical Properties of Materials, Troy, N.Y., August 1988

"Fibers and Waveguides for Nonlinear Optics", Nonlinear Optical Properties of Materials, Troy, N.Y., August 1988

"Review of Nonlinear Guided Wave Devices", OMNA'88, Oxford, June 1988

"Nonlinear Waveguide Phenomena in Organic Polymers", NATO Advanced Research Workshop, Nice France, June 1988

"Progress in Nonlinear Integrated Optics", (given by R. Zanoni) The International Conference on Nonlinear Optical Phenomena, Ashford Castle, Ireland, May 1988

"Organic Materials for Nonlinear Integrated Optics", AFOSR Contractors Meeting, Washington, April 1988

"Nonlinear Guided Wave Characteristics", Integrated and Guided Wave Optics 88, Santa Fe, New Mexico, March 1988

"Nonlinear Integrated Optics", Electrooptics Review Panel, Taiwan, January 1988

"Planar Nonlinear Guided Wave Phenomena", Winter Quantum Electronics Conference, Snowbird Utah, January 1988

"Materials and Devices for Nonlinear Guided Waves", (given by N. Finlayson) SPIE Conference on Optical Computing and Nonlinear Materials", Los Angeles, January 1988

"Nonlinear Organic Materials in Integrated Optics", Materials Research Society, Boston, December 1987

"Nonlinear Guided Wave Devices: Material Requirements", SPIE Conference, Cannes France, November 1987

"Nonlinear Waveguides", (given by C.T. Seaton) 1987 International Topical Meeting on Optical Bistability, Instability and Optical Computing, Beijing, August 1987

"Nonlinear Optics in Planar Waveguides", SPIE short course, San Diego, August 1987

"Nonlinear Thin Film Devices: Applications and Material Requirements", DARPA Workshop on Nonlinear Optical Materials and Devices, La Jolla, July 1987

"Nonlinear Optics in Waveguides", Annual Meeting of Canadian Association of Physicists, Toronto, June 1987

"Linear and Nonlinear Optical Phenomena at Surfaces", USA-USSR Binational Symposium on Laser Optics of Condensed Matter, Leningrad, June 1987

"Non-linear Effects in Surface Plasmon and Guided Mode Propagation", The Rank Prize Funds Meeting on Two-Dimensional Plasmons", Malvern, UK, May 1987

"Surface Acoustooptics", Celebration Meeting for 50'th Anniversary of Istituto di Acoustica "O.M. Corbino", Rome, April 1987

"Experiments in and Device Applications of Nonlinear Waveguides", Workshop on State of the Art Developments in Nonlinear Optics, Dept. of Mathematics, Un. of Arizona, March 1987

"The State of the Art of, and Future Research Needs in Integrated Optics Structures", NSF Workshop on The Molecular Engineering of Ultrathin Polymeric Films, UC Davis, February 1987

"Nonlinear Integrated Optics: Materials and Devices", (given by C.T. Seaton), Basic Science, Glass and Electronics Joint Meeting of the American Ceramic Society, New Orleans, November 1986

"Soliton Effects in Nonlinear Waveguides", 11'th Workshop on Optical Waveguide Theory, Madrid, Spain, September 1986

"Third Order Nonlinear Guided Wave Optics", (given by C.T. Seaton) SPIE Conference on Molecular and Polymeric Optoelectronic Materials: Fundamentals and Applications, San Diego, August 1986

"Nonlinear Waves Guided by Multilayer Media", International Symposium on Surface Waves in Solids and Layered Structures", Novosibirsk, USSR, July 1986

"Recent Developments in Nonlinear Guided Waves", Conference on Lasers and Electrooptics" (CLEO), San Francisco, June 1986

"Brillouin Scattering from Langmuir-Blodgett Films", Gordon Conference on Organic Films, Santa Barbara, February 1986

"Nonlinear Guided Wave Phenomena", Topical Conference on Optical Bistability, Tucson, December 1985

"Nonlinear Integrated Optics", 5'th International Conference on Integrated Optics and Optical Fibre Communications, Venice, Italy, October 1985

"Nonlinear Planar Guided Wave Interactions", AGARD (NATO) Meeting on Guided Optical Structures, Istanbul, Turkey, September 1985

"New Developments in Nonlinear Waveguide Theory", 10'th Workshop on Optical Waveguide Theory, Castelgandolfo, Italy, September 1985

"Intensity-Dependent Guided Wave Phenomena", 2'nd International Conference on Optical Circuit Engineering, Cambridge, September 1985

"Nonlinear Guided Wave Phenomena: Physics and Applications", Trends in Quantum Electronics '85, Bucharest, September 1985

"Nonlinear Waves Guided by Surfaces", 2'nd International Conference on Surface Waves, Ohrid Yugoslavia, September 1985

"Nonlinear Guided Wave Phenomena", 4 lectures jointly presented at Ettore Majorana Summer School on "Surface Electromagnetic Excitations" and at Summer School on "Nonlinear Optics", Erice Italy, July 1985

"Nonlinear Third Order Integrated Optics", European Conference on Integrated Optics (EICO'85), Berlin West Germany, May 1985

"Beam Steering with Nonlinear Gratings", DARPA Workshop on Optical Interconnects, San Diego, July 1984

"Nonlinear Surface Polaritons", lecture at Ettore Majorana Summer School on "Dynamical Phenomena at Surfaces, Interfaces and Superlattices", Erice Italy, July 1984

"Nonlinear Guided Wave Gratings", ARO Workshop on Optical Switching, Irvine, March 1984

"Applications of Nonlinear Optics with Guided Waves", Royal Society Meeting on Optical Bistability, Dynamical Nonlinearity and Photonic Logic, London, March 1984